

## Lithium

Sanyo Lithium Batteries



# [ Battery Handling Precautions for Your Own Safety ]

Lithium batteries contain combustible materials such as lithium metal and organic solvent. Improper handling can lead to heat generation, bursting or fire. To prevent accidents, follow these precautions and refer to them when precautions regarding lithium battery usage are described in instruction manuals for equipment you are using.

## Coin-type Primary and Rechargeable Lithium Batteries

### **WARNING!**

#### **1. Do not charge. (Primary batteries, CR series).**

When this battery is charged, gas is generated inside and raises internal pressure, resulting in fire, heat generation, leakage or bursting.

#### **2. Do not heat, disassemble nor dispose of in fire.**

Doing so damages the insulation materials or the safety vent, resulting in fire, heat generation, leakage or bursting.

#### **3. Do not insert batteries with the ⊕ and ⊖ polarities reversed.**

Make sure the polarities are in the right position when inserting the batteries into equipment. When using 3 or more batteries, the equipment may operate even though one of the batteries is improperly inserted. But this may cause leakage or bursting.

#### **4. Do not short-circuit.**

If the ⊕ and ⊖ come into contact with metal objects, short circuiting occurs resulting in heat generation or bursting. When carrying or storing batteries, avoid direct contact with metal objects such as bracelets or key chains by putting them in a separate bag.

#### **5. Keep batteries out of children's reach.**

If leaked liquid is ingested or a battery is swallowed, consult a physician immediately.

#### **6. In case of leakage or a strange smell, keep away from fire to prevent ignition of any leaked electrolyte.**

#### **7. Do not solder directly.**

This can damage the insulation materials, resulting in fire, heat generation, leakage or bursting.

#### **8. Be sure to wrap each battery when disposing or storing to avoid short circuit.**

Putting batteries together or in contact with metal objects causes short circuiting, resulting in fire, heat generation or bursting.

#### **9. Do not force-discharge.**

When a battery is force-discharged by an external power source, the voltage drops to 0 or less (reversal voltage) and gas is generated inside the battery. This may cause fire, heat generation, leakage or bursting.

#### **10. Do not charge with high current and high voltage. (Rechargeable batteries, ML, NBL series).**

Doing so may generate gas inside the battery, resulting in swelling, fire, heat generation or bursting.

### **CAUTION!**

#### **1. If leaked liquid gets in the eyes, wash them with clean water and consult a physician immediately.**

#### **2. Do not use new and used batteries together. Do not use different types of batteries together.**

Doing so may cause heat generation, leakage or bursting.

#### **3. Do not apply strong pressure to the batteries nor handle roughly.**

Doing so may cause heat generation, leakage or bursting.

#### **4. Do not use nor leave the batteries in direct sunlight nor in high-temperature areas.**

Doing so may cause heat generation, leakage or bursting.

#### **5. Avoid contact with water.**

Doing so may cause heat generation.

#### **6. Make sure to insert batteries without having the ⊕ and ⊖ come in contact with metal parts of equipment.**

#### **7. Read the equipment instruction manual and precautions carefully before use. Some usages or types of equipment do not suit the specifications or performance of these batteries.**

#### **8. Keep batteries away from direct sunlight, high temperature and humidity.**

Leaving batteries in such places may cause heat generation.

#### **9. For proper disposal, follow local government regulations.**

## Cylindrical-type Primary Lithium Batteries



### **WARNING!**

**"DO NOT CHARGE"**

1. Do not use batteries for unspecified purposes.

Differences in voltage or terminal configuration may cause an imperfect connection, fire, heat generation, leakage or bursting.

2. Do not charge.

When this battery is charged, gas is generated inside and raises internal pressure, resulting in fire, heat generation, leakage or bursting.

3. Do not heat, disassemble nor dispose of in fire.

Doing so damages the insulation materials or the safety vent, resulting in fire, heat generation, leakage or bursting.

4. Do not insert batteries with the  $\oplus$  and  $\ominus$  polarities reversed.

Make sure the polarities are in the right position when inserting the batteries into equipment. When using 3 or more batteries, the equipment may operate even though one of the batteries is improperly inserted. But this may cause leakage or bursting.

5. Do not short-circuit.

If the  $\oplus$  and  $\ominus$  come into contact with metal objects, short circuiting occurs resulting in heat generation or bursting. When carrying or storing batteries, avoid direct contact with metal objects such as bracelets or key chains by putting them in a separate bag.

6. Keep batteries out of children's reach.

If leaked liquid is ingested or a battery is swallowed, consult a physician immediately.

7. In case of leakage or a strange smell, keep away from fire to prevent ignition of any leaked electrolyte.

8. Do not use new and used batteries together. Do not use different types of batteries together.

Doing so may cause fire, heat generation, leakage or bursting.

9. Do not solder directly.

Doing so may cause damage to insulation materials. It may also cause fire, heat generation, leakage or bursting.

10. Do not apply strong pressure nor handle roughly.

Doing so may cause fire, heat generation, leakage or bursting.

11. To prevent damage to the safety vent inside the battery, do not deform in any way.

12. Do not force-discharge.

When a battery is force-discharged by an external power source, the voltage drops to 0 or less (reversal voltage) and gas is generated inside the battery. This may cause fire, heat generation, leakage or bursting.

13. Do not damage nor peel off the resin film on the surface of the battery.



### **CAUTION!**

1. If leaked liquid gets in the eyes, wash them with clean water and consult a physician immediately.

2. Do not use nor leave the batteries in direct sunlight nor in high-temperature areas.

Doing so may cause heat generation, leakage or bursting.

3. Avoid contact with water.

This can cause heat generation.

4. Read the equipment instruction manual and precautions carefully before use. Some usages or types of equipment do not suit the specifications or performance of these batteries.

5. Keep batteries away from direct sunlight, high temperature and humidity.

Leaving batteries in such places may cause heat generation.

6. Be sure to wrap each battery when disposing or storing to avoid short circuit.

Putting batteries together or in contact with metal objects causes short circuiting, resulting in fire, heat generation or bursting.

7. For disposal, follow local government regulations.

## [ Precautions for Designing Equipment ]

For further information, refer to the Connection Terminal Specifications for Lithium Batteries and Key Circuit Design Points which is available upon request.

Featuring compact dimensions,  
high energy capacity and long-term  
durability, lithium batteries  
successfully meet today's needs.



## [ Sizes and Models of Lithium Batteries ]

Sanyo lithium battery dimensions and models are as follows:

### Coin Type Lithium Batteries

height \ diameter	4.8	6.8	12.5	20.0	24.5
1.4	ML414 ML414R NBL414	ML614			
2.1	ML421	ML621 NBL621			
1.6				CR2016 ML2016	
2.0			CR1220 ML1220	ML2020	
2.5				CR2025	
3.0					CR2430 ML2430
3.2				CR2032	
5.0					CR2450

(unit : mm)

### Cylindrical Type Primary Lithium Batteries

height \ diameter	11.6	12.0	13.0	14.5	15.5	17.0	23.0
10.8	CR-1/3N						
25.0				CR14250SE			
25.2			2CR-1/3N				
27.0					CR15270 CR2		
33.5						CR17335E-R CR17335HE-R CR17335SE	
33.8						CR17335	
34.5						CR123A	
40.0					CR15400		
45.0						CR17450E-R CR17450HE-R CR17450SE	
50.0							CR23500SE
60.0		CR12600SE					

(unit : mm)

Model numbers are based on a code, as shown by the following examples:

Example 1

**C R 20 25**

height (2.5mm)  
diameter (20.0mm)  
shape (round)  
type  
(manganese dioxide/  
primary lithium battery)

Example 2

**2 CR -1/3N**

height (1/3 of N size)  
for connection in series (2)

Example 3

**CR 17 450 E-R**

rupture vent  
laser-welding  
height (45.0mm)  
diameter (17.0mm)

Example 4

**CR 17 335 S E**

laser-welding  
bobbin structure  
height (33.5mm)  
diameter (17.0mm)

Example 5

**ML414R**

reflowable

ML : Manganese Dioxide Rechargeable Lithium Batteries  
NBL : Niobium Rechargeable Lithium Batteries

# Manganese Dioxide Primary Lithium Batteries (CR series)

Sanyo manganese dioxide primary lithium batteries, developed in 1976, feature high energy density. Because they offer many unique features not found in either conventional dry cells or silver oxide batteries, Sanyo lithium batteries are currently used in a wide range of equipment such as electronic calculators, watches and cameras. In addition, they are used as a memory backup power source in microcomputer-controlled devices. By offering a wide range of lithium batteries, from coin cells to high-power cylindrical type cells (spiral structure) and high-capacity cylindrical type cells (bobbin structure), Sanyo has been able to meet the demands of a large and diversified market. Sanyo is acquiring International Regulation ISO9001 approval which is a quality guarantee. Sanyo continues to implement thorough quality control.

## [ Principles and Structure of Primary Lithium Batteries ]

Applying an original manufacturing process, Sanyo uses a manganese dioxide compound as the active material for the positive electrode (cathode). Lithium is used for the negative electrode (anode) to produce a cell with high voltage and high energy density. In addition, an organic electrolyte is employed to which lithium salts are added.

The discharge reaction of lithium batteries is as follows:

Anode reaction:  $\text{Li} \rightarrow \text{Li}^+ + \text{e}^-$

Cathode reaction:  $\text{MnO}_2 + \text{Li}^+ + \text{e}^- \rightarrow \text{MnO}_2(\text{Li}^+)$

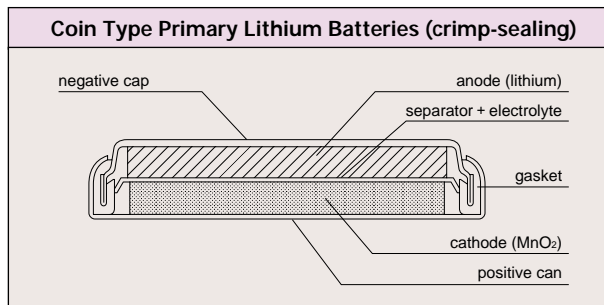
Overall battery reaction:  $\text{MnO}_2 + \text{Li} \rightarrow \text{MnO}_2(\text{Li}^+)$

The cell voltage is approximately 3V.

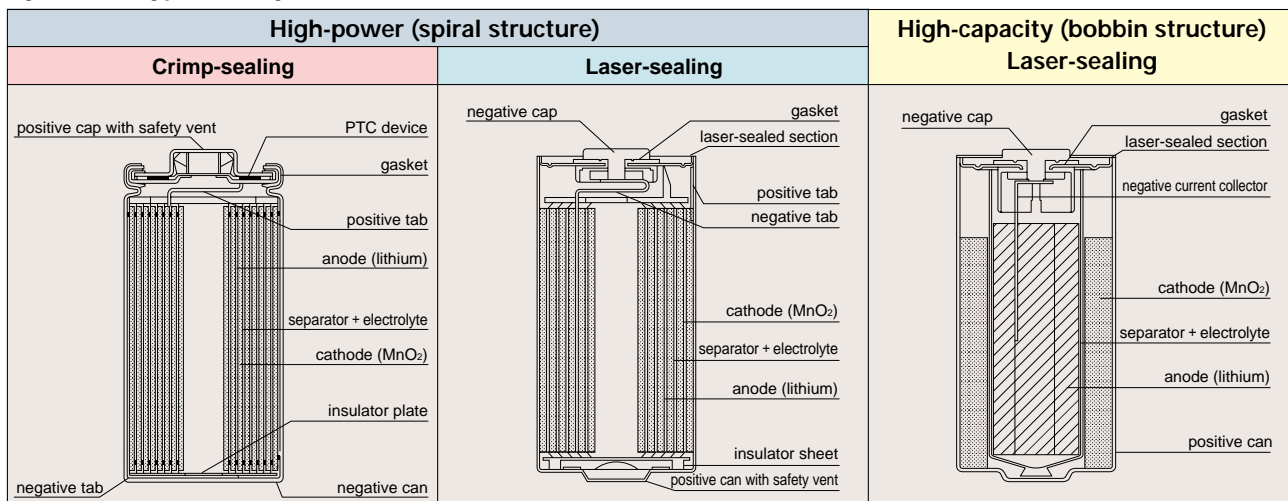
### Battery Structure

High-power cylindrical type lithium batteries are capable of producing a very high discharge current due to their spiral electrode structure. High-capacity cylindrical type lithium batteries have a bobbin structure which contains active material and can provide a high capacity.

In addition, the laser sealing technology ensures long-term reliability and a battery life of up to 10 years at room temperature.



### Cylindrical Type Primary Lithium Batteries

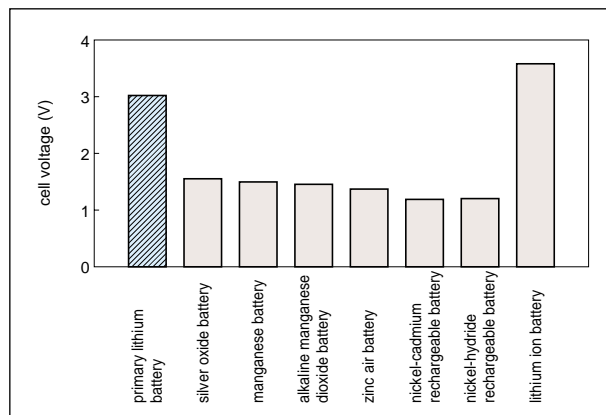


## [ Features of Primary Lithium Batteries ]

### Stable Operating Voltage of 3V

Lithium batteries have a high discharge voltage of 3 volts. Thus a single lithium battery can be used to replace two or three conventional silver oxide or manganese batteries (1.5V). The stable operating voltage over as long as 10 years, at room temperature, ensures outstanding performance, quality and reliability.

Nominal Voltage of Major Batteries



### More Than 95% of Initial Capacity Even After 10 Years

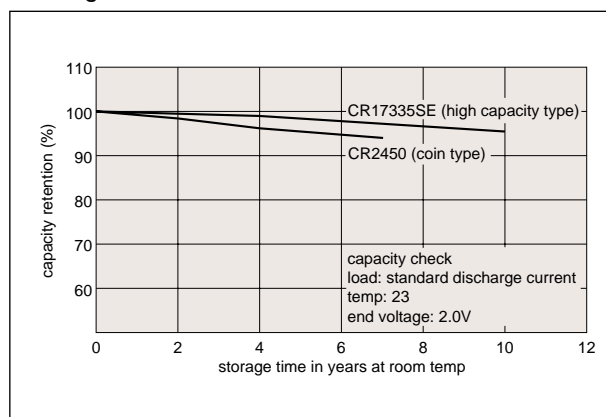
A stable electrolyte, Sanyo's superior manufacturing methods and sealing technology combine to ensure that the tendency of lithium batteries to self-discharge is reduced to a very low level. Even after 10 years of storage at room temperature, more than 95% capacity is retained.

Self-discharge rate per year at room temperature:

Coin type primary battery:	under 1%
High-power cylindrical type primary battery:	
Crimp-sealing	under 1%
Laser-sealing	under 0.5%
High-capacity cylindrical type primary battery:	under 0.5%

Storage Characteristics

CR2450, CR17335SE



### - 40 to +85 Operational Temperature Range

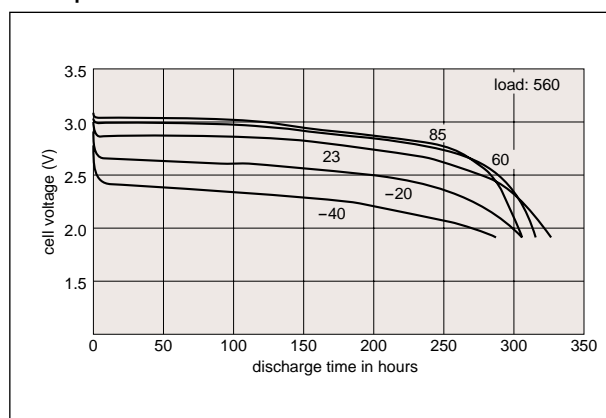
Sanyo lithium batteries have an organic electrolyte with a very low freezing point, which guarantees reliable operation even at extremely low temperatures.

Additionally, rigorous selection of materials and superior sealing technology give these batteries excellent characteristics even at high temperatures.

Coin type primary battery:	- 20	~ + 70
High-power cylindrical type primary battery:		
Crimp-sealing	- 40	~ + 60
Laser-sealing	- 40	~ + 85
High-capacity cylindrical type primary battery:	- 40	~ + 85

Temperature Characteristics

CR17335E-R



### Superior Leakage Resistance

The use of an organic solvent rather than an alkali for the electrolyte significantly minimizes leakage. Furthermore, laser sealing technology also minimizes the risk of electrolyte leakage.

### Greater Safety (UL approved)

Since Sanyo primary lithium batteries do not contain toxic materials, noxious liquids or gases, they pose no major pollution problems. They are UL recognized components (File No. MH12383).

# [ Coin Type Primary Lithium Batteries ]



## Features

Low self-discharge rate and long life.  
 Self-discharge rate: less than 1% a year at room temperature.  
 Stable discharge characteristics (uniform discharge voltage).  
 Superior high-rate pulse discharge characteristics.  
 Usable over a wide temperature range.  
 Operational temperature range: - 20 to + 70  
 Consult Sanyo when using batteries at temperatures exceeding the - 20 to + 60 range.  
 Superior leakage resistance.  
 Extremely safe (UL recognized component; File No. MH12383).

## Applications

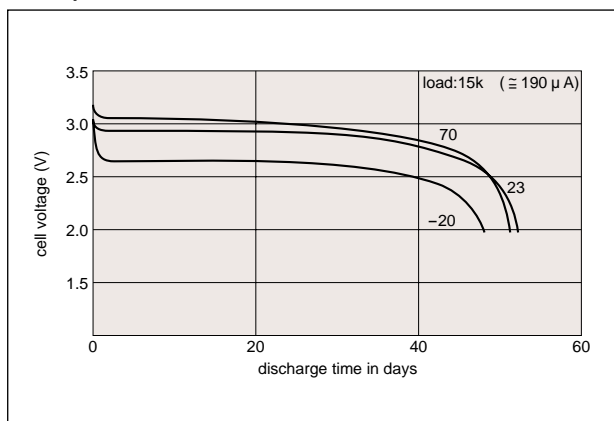
watches (digital and analog) calculators electronic notebooks  
 electronic keys for automobiles card radios PC cards  
 LED-related medical equipment  
 memory backup power source

### When the batteries are used with a contact system

Use nickel-plated phosphor bronze or stainless steel for terminal materials to make contact with the batteries.  
 For stable contact conditions, several N of contact pressure are recommended for the contact.

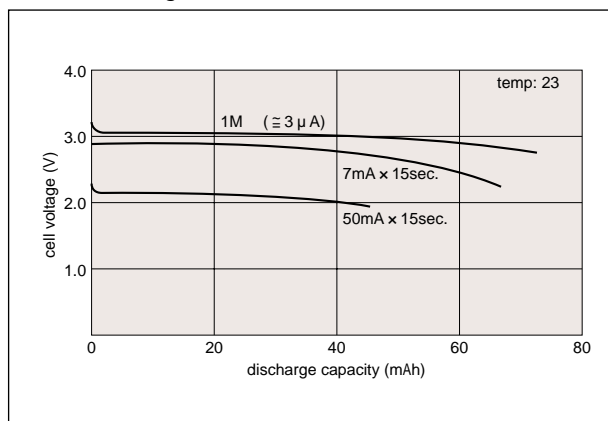
Temperature Characteristics

CR2032



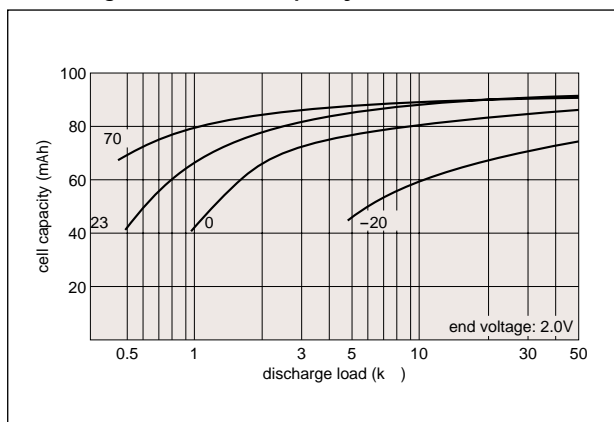
Pulse Discharge Characteristics

CR2016



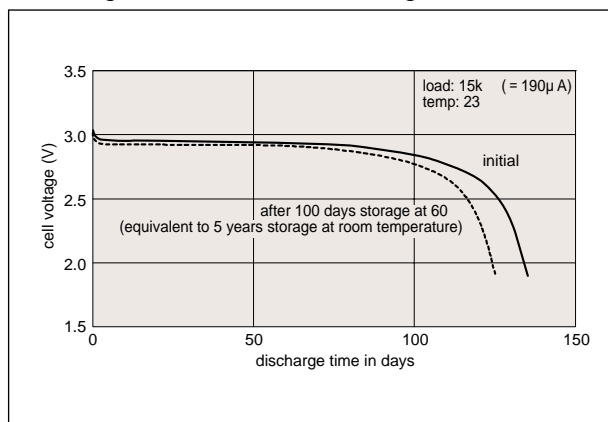
Discharge Load vs. Cell Capacity

CR2016



Discharge Characteristics After Storage

CR2450



## [ High-power Cylindrical Type Primary Lithium Batteries ]



### Features

A single lithium battery generates approx. 3V, twice the output of conventional batteries.

Spiral electrode structure ensures high-rate current discharge.

Low self-discharge rate and long life.

Self-discharge rate: less than 1% a year at room temperature.

Usable over a wide temperature range.

Operational temperature range:

Crimp-sealing type: - 40 to + 60

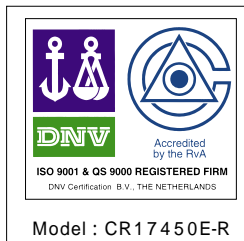
Laser-sealing type: - 40 to + 85

Consult Sanyo when using batteries at temperatures exceeding the - 20 to + 60 range.

Stable discharge characteristics.

Superior leakage resistance.

Extremely safe (UL recognized component: File No. MH12383).



### Applications

fully automatic cameras with flash and exposure meter DSC  
lighting radios electronic locks medical equipment  
water, gas and electricity meters memory backup power sources

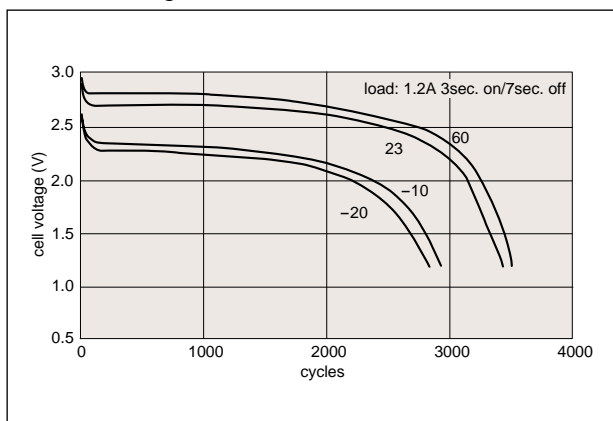
### When the batteries are used with a contact system

Use nickel-plated phosphor bronze or stainless steel for terminal materials to make contact with the batteries.

For stable contact conditions, several N of contact pressure are recommended for the contact.

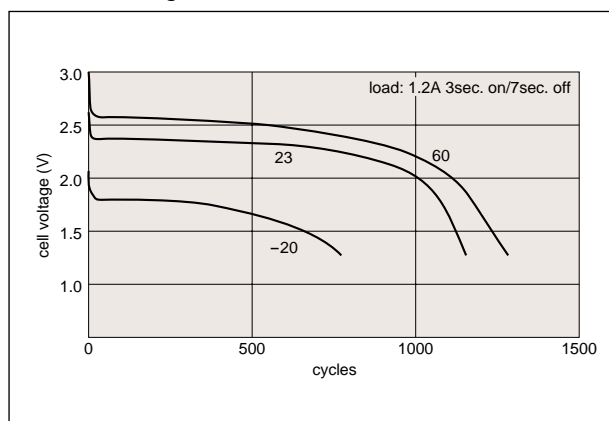
Pulse Discharge Characteristics

CR-V3



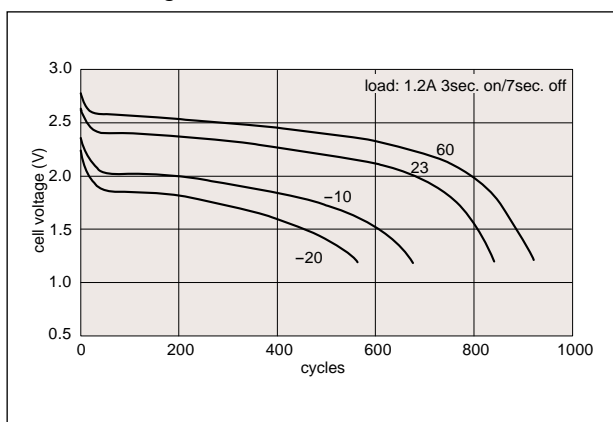
Pulse Discharge Characteristics

CR123A



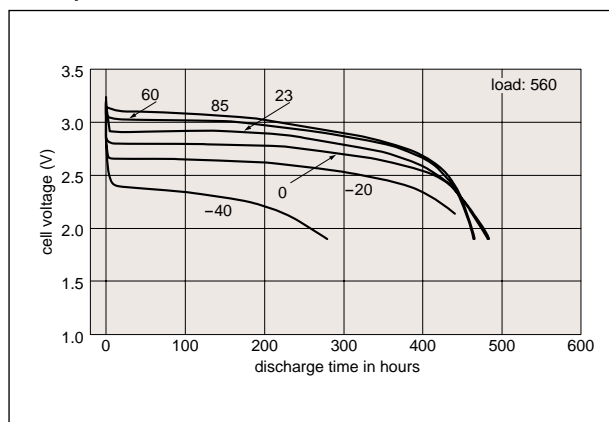
Pulse Discharge Characteristics

CR2



Temperature Characteristics

CR17450E-R



# [ High-capacity Cylindrical Type Primary Lithium Batteries ]



## Features

A single lithium battery produces approx. 3V, twice the output of conventional batteries.

Low self-discharge rate and long life.

Self-discharge rate: less than 0.5% a year at room temperature.

Stable discharge characteristics (uniform discharge voltage).

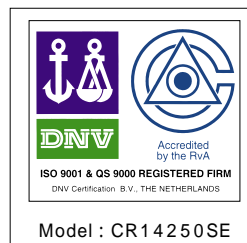
Usable over a wide temperature range.

Operational temperature range: - 40 to + 85

Consult Sanyo when using batteries at temperatures exceeding the - 20 to + 60 range.

Superior leakage resistance.

Extremely safe (UL recognized component: File No. MH12383).



## Applications

Water, gas and electricity meters

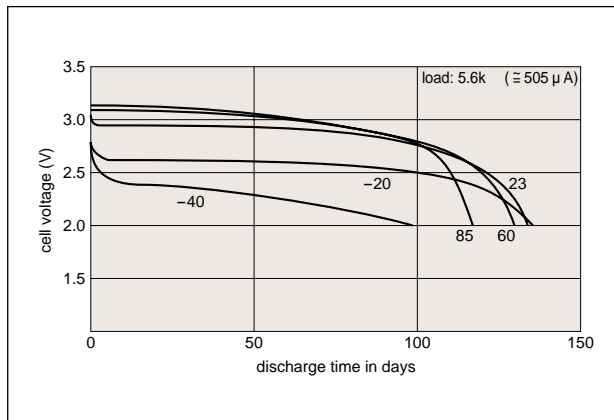
Memory backup power sources for office and factory automation equipment

Main power sources and memory backup power sources for car electronics

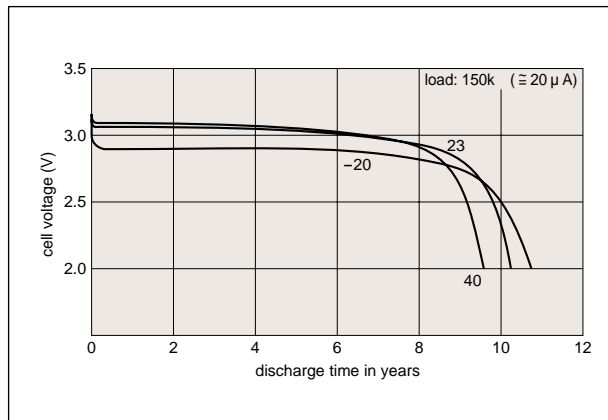
Various memory backup power sources.

Temperature Characteristics

CR12600SE

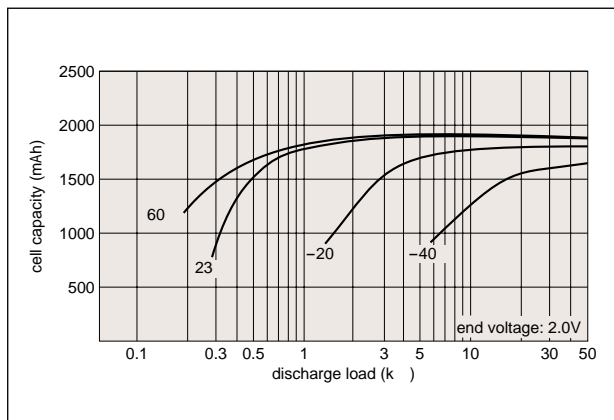


Discharge Characteristics (low-rate discharge) CR17335SE



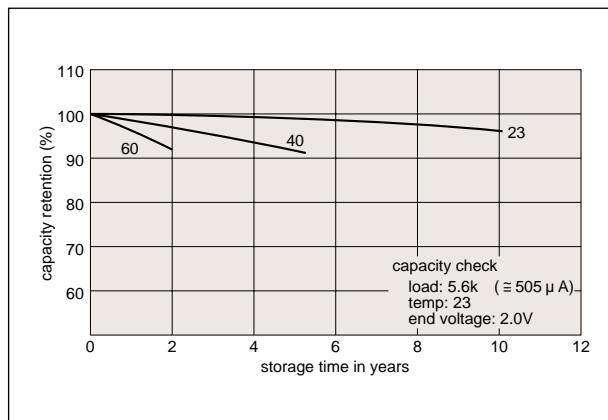
Discharge Load vs. Cell Capacity

CR17335SE



Capacity Retention

CR17335SE



## [ Specifications of Primary Lithium Batteries ]

### Coin Type Primary Lithium Batteries

Model	Nominal voltage (V)	Nominal <sup>1</sup> capacity (mAh)	Standard discharge current (mA)	Max. discharge current (mA)		Max. dimensions (mm)		Weight (g)	Reference Model No.
				continuous <sup>2</sup>	pulse <sup>3</sup>	diameter (D)	height (H)		IEC type
CR1220	3	36	0.1	2	10	12.5	2.0	0.8	CR1220
CR2016	3	80	0.3	5	50	20.0	1.6	1.7	CR2016
CR2025	3	150	0.3	5	40	20.0	2.5	2.5	CR2025
CR2032	3	220	0.3	4	20	20.0	3.2	3.0	CR2032
CR2430	3	280	0.3	5	50	24.5	3.0	4.0	CR2430
CR2450	3	610	0.2	2	30	24.5	5.0	6.9	CR2450

Operational temperature range: - 20 to + 70

Consult Sanyo when using batteries at temperatures exceeding the - 20 to + 60 range.

### High-power Cylindrical Type Primary Lithium Batteries (spiral structure, crimp-sealing)

Model	Nominal voltage (V)	Nominal <sup>1</sup> capacity (mAh)	Standard discharge current (mA)	Max. discharge current (mA)		Max. dimensions (mm)		Weight (g)	Reference Model No.
				continuous <sup>2</sup>	pulse <sup>3</sup>	diameter (D)	height (H)		IEC type
CR-1/3N	3	160	2	60	80	11.6	10.8	3.3	CR11108
2CR-1/3N	6	160	2	60	80	13.0	25.2	9.1	2CR11108
CR15270 *	3	850	10	1000	2500	15.5	27.0	11	CR15G270
CR15400 *	3	1400	10	1500	3500	15.5	40.0	17	CR15G400
CR17335 *	3	1400	10	1500	3500	17.0	33.8	16	CR17338
CR2	3	850	10	1000	2500	15.6	27.0	11	CR15H270
CR123A	3	1400	10	1500	3500	17.0	34.5	17	CR17345
CR-V3	3	3300	20	3500	7000	29.0( L ) x 14.5( W ) x 52.0( H )		38	CP3152
CR-P2	6	1400	10	1500	3500	34.8( L ) x 19.5( W ) x 35.8( H )		37	2CP4036
2CR5	6	1400	10	1500	3500	34( L ) x 17( W ) x 45( H )		40	2CP3845

Operational temperature range: - 40 to + 60

Consult Sanyo when using batteries at temperatures exceeding the - 20 to + 60 range.

CR15270, CR17335, CR2, CR123A, CR-V3, CR-P2 and 2CR5 incorporate a PTC device to prevent overheating and excess discharging current.

### High-power Cylindrical Type Primary Lithium Batteries (spiral structure, laser-sealing)

Model	Nominal voltage (V)	Nominal <sup>1</sup> capacity (mAh)	Standard discharge current (mA)	Max. discharge current (mA)		Max. dimensions (mm)		Weight (g)	Reference Model No.
				continuous <sup>2</sup>	pulse <sup>3</sup>	diameter (D)	height (H)		IEC type
CR17335E-R *	3	1500	5	700	2500	17.0	33.5	16	CR17335
CR17335HE-R *	3	1350	5	1000	3000	17.0	33.5	16	CR17335
CR17450E-R *	3	2200	5	1000	2500	17.0	45.0	22	CR17450
CR17450HE-R *	3	2000	5	1500	3500	17.0	45.0	22	CR17450

Operational temperature range: - 40 to + 85

Consult Sanyo when using batteries at temperatures exceeding the - 20 to + 60 range.

### High-capacity Cylindrical Type Primary Lithium Batteries (bobbin structure, laser-sealing)

Model	Nominal voltage (V)	Nominal <sup>1</sup> capacity (mAh)	Standard discharge current (mA)	Max. discharge current (mA)		Max. dimensions (mm)		Weight (g)	Reference Model No.
				continuous <sup>2</sup>	pulse <sup>3</sup>	diameter (D)	height (H)		IEC type
CR14250SE *	3	850	0.5	7	70	14.5	25.0	9	CR14250
CR12600SE *	3	1500	1.0	15	250	12.0	60.0	15	CR12600
CR17335SE *	3	1800	1.0	8	100	17.0	33.5	17	CR17335
CR17450SE *	3	2500	1.0	9	150	17.0	45.0	22	CR17450
CR23500SE *	3	5000	1.0	10	200	23.0	50.0	42	CR23500

Operational temperature range: - 40 to + 85

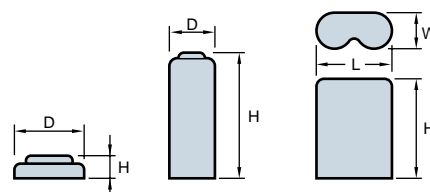
Consult Sanyo when using batteries at temperatures exceeding the - 20 to + 60 range.

All batteries listed above, except for the CR12600SE, are also available in models with safety vents (SE-R).

\* Denotes models supplied with extra terminals.

Note: IEC type in the above tables conform to the IEC86-1 notation system.

- Nominal capacity is determined at an end voltage of 2.0V (4.0V for 6V models) when the battery is allowed to discharge at a standard current level at 23 °C.
- Current value is determined to be the level at which 50% of the nominal capacity is obtained with an end voltage of 2.0V (4.0V for 6V models) at 23 °C.
- Current value for obtaining 2.0V cell voltage (4.0V for 2CR-1/3N) when pulse is applied for 15 seconds at 50% discharge depth (50% of the nominal capacity) at 23 °C.  
For CR15270, CR15400, CR17335, CR2, CR123A, CR-V3, CR17335E-R, CR17335HE-R, CR17450E-R and CR17450HE-R, however, the current values for obtaining 1.0V are listed.



# Manganese Dioxide Rechargeable Lithium Batteries (ML series)

Sanyo manganese dioxide rechargeable lithium batteries are high-capacity rechargeable coin-type batteries. These batteries have a high voltage of 3V compared to Ni-Cd button cells (1.2V). With a low self-discharge rate and superior charge/discharge cycle characteristics, they have an expected life of as much as 5 years at room temperature. They are suitable for use as memory backup power sources and can also be used in combination with solar cells.

## [ Principles and Structure of Coin Type Manganese Dioxide Rechargeable Lithium Batteries ]

Manganese dioxide, with proven performance, is used as the active material for the positive electrode through Sanyo's developed treatment. The active material in the negative electrode, lithium aluminum alloy, offers stable cyclic performance with a high discharge voltage. The electrolyte is made by dissolving lithium salts in a mixed organic solvent. The charge/discharge reaction of the batteries is as follows:

Anode reaction:  $(\text{Li} - \text{Al}) \rightarrow \text{Al} + \text{Li}^+ + \text{e}^-$

Cathode reaction:  $\text{MnO}_2 + \text{Li}^+ + \text{e}^- \rightarrow \text{MnO}_2(\text{Li}^+)$

Overall battery reaction:  $\text{MnO}_2 + (\text{Li} - \text{Al}) \rightarrow \text{MnO}_2(\text{Li}^+) + \text{Al}$

The cell voltage is approximately 3V.

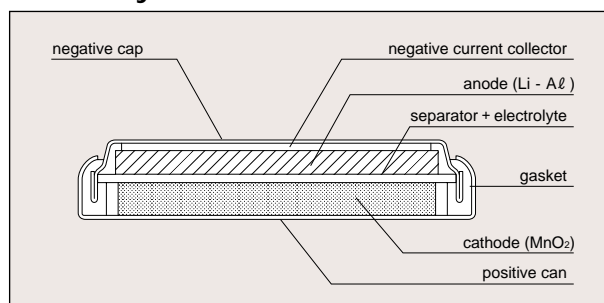


### When the batteries are used with a contact system

Use nickel-plated phosphor bronze or stainless steel for terminal materials to make contact with the batteries.

For stable contact conditions, several N of contact pressure are recommended for the contact.

## Battery Structure



## Applications

Memory backup power sources for computer, MD and portable cellular phones including PHS.

Power source for portable equipment.

Hybrid power source when combined with solar cells

Memory backup power source for electronic equipment.

## [ Features of Coin Type Manganese Dioxide Rechargeable Lithium Batteries ]

### Continued Backup Over One Year

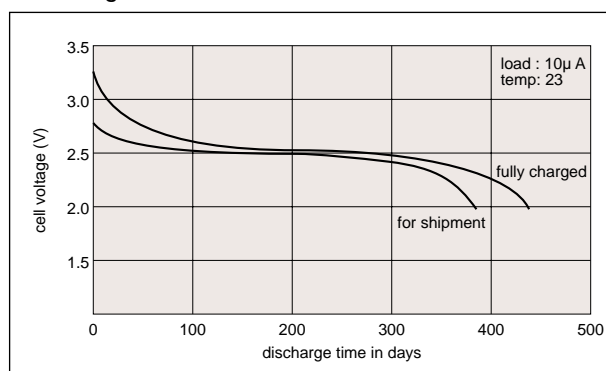
The ML2430, for example, offers one year back up under continuous discharge of  $10\mu\text{A}$  at 23°C when the battery is fully charged or when the battery capacity is the same as the shipment.

### Stable Operating Voltage of 2.5V

Sanyo rechargeable lithium batteries offer a high discharge voltage of 2.5V, more than twice that of Ni-Cd button cells. So a single lithium battery can be used to replace two conventional batteries. They also offer a stable voltage over a long period, unlike the straight-line voltage drop of capacitors.

### Discharge

ML2430



## Superior Charge/Discharge Characteristics (ML2430)

Our batteries can withstand 20,000 cycles, 3,000 cycles and 500 cycles under discharge conditions of 1.0mAh (discharge depth of 1%), 5.0mAh (discharge depth of 5%) and 20mAh (discharge depth of 20%) respectively.

## Wide Operating Temperature Range

The use of an organic electrolyte gives an extended operating temperature range: - 20 to + 60 .

## Charging Possible with 2.8V

Even a charging voltage as low as 2.8V ensures high charge efficiency.

## Excellent Continuous Charging Performance

Stable characteristics are maintained even when continuously charged for long periods.

## Superior Overcharging Performance

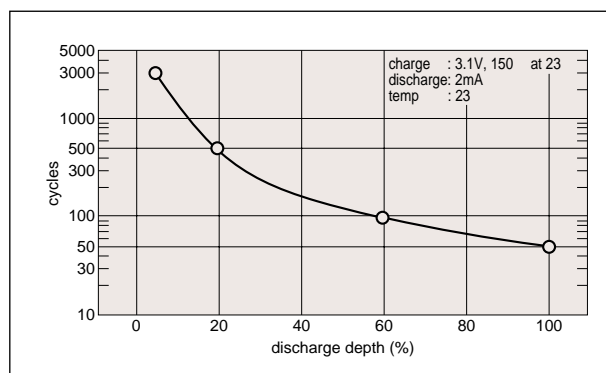
The use of an organic solvent rather than an alkali for the electrolyte and superior sealing technology significantly reduce the risk of leakage.

## Small Self-Discharge Rate Assures Durability

The self-discharge rate of approx. 2% per year at room temperature is much lower than that of Ni-Cd button cells. Even after five years of storage at room temperature, you can expect about 90% of the original capacity.

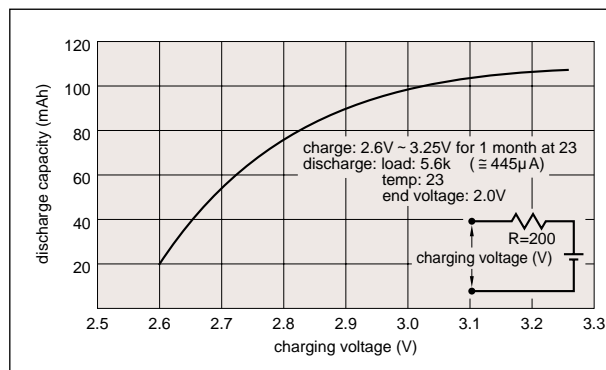
## Charge/Discharge Cycle Characteristics

ML2016



## Charging Voltage vs. Cell Capacity

ML2430



## Greater Safety (UL approved)

Since Sanyo manganese dioxide rechargeable lithium batteries do not contain toxic materials, noxious liquids or gases, they pose no major pollution problems. They are UL recognized components: (File No. MH12383).

## [ Specifications of Manganese Dioxide Rechargeable Lithium Batteries ]

Model	Nominal voltage (V)	Nominal capacity <sup>1</sup> (mAh)	Standard charge/discharge current (mA)	Max. discharge current (mA)		Charge/discharge cycle characteristics	Charging method	Dimensions (mm)		Weight (g)
				continuous <sup>2</sup>	pulse <sup>3</sup>			diameter (D)	height (H)	
ML414	3	1.0	0.005	0.2	0.6	3,000 cycles (discharge depth of 5%)	3.1 ± 0.15V	4.8	1.4	0.07
ML421	3	2.3	0.005	0.2	0.6			4.8	2.1	0.1
ML614	3	3.4	0.015	0.5	1.5			6.8	1.4	0.16
ML621	3	5.5	0.015	0.5	1.5	300 cycles (discharge depth of 20%)	2.95 ± 0.15V (charge at high temperature or continuously)	6.8	2.1	0.22
ML1220*	3	15	0.1	2	5			12.5	2.0	0.8
ML2016*	3	30	0.3	8	20			20.0	1.6	1.8
ML2020*	3	45	0.3	8	20	500 cycles (discharge depth of 20%)		20.0	2.0	2.2
ML2430*	3	100	0.5	10	20			24.5	3.0	4.1
ML414R* <sub>4</sub>	3	0.1	0.005	0.02	0.05	100 cycles (discharge depth of 100%)		4.8	1.4	0.07

\* Denotes models supplied with extra terminals.

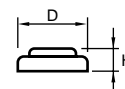
1 Nominal capacity is determined to an end voltage of 2.0V when the battery is allowed to discharge at a standard current level at 23 .

2 Current value is determined so that 50% of the nominal capacity is obtained with an end voltage of 2.0V at 23 .

3 Current value for obtaining 2.0V cell voltage when 15sec. pulse applied at 50% discharge depth at 23 .

4 ML414R is able to use the reflow soldering process.

Consult Sanyo for details of items not described in this catalog.



# Niobium Rechargeable Lithium Batteries (NBL series)

Sanyo niobium rechargeable lithium batteries are high-capacity coin-type batteries that can be recharged at 2.0V. These batteries are specially designed for use with low-voltage equipment. Similarly with the ML-series manganese dioxide rechargeable lithium batteries, the NBL-series features a low self-discharge rate, thus offering an expected life of 5 years at room temperature. These batteries are optimized for use as memory backup power sources and can also be used in combination with solar cells.

## [ Principles and Structure of Coin Type Niobium Rechargeable Lithium Batteries ]

These batteries use niobium pentoxide as the active material for the positive electrode by employing Sanyo's original treatment process. In turn, the active material for the negative electrode is made from lithium aluminum alloy. This allows stable cyclic performance to be maintained at a low discharge voltage. The electrolyte is made by dissolving lithium salts in a mixed organic solvent.

The charge/discharge reaction of the batteries is as follows: Anode reaction:  $(\text{Li} - \text{Al}) \rightarrow \text{Al} + \text{Li}^+ + \text{e}^-$

Cathode reaction:  $\text{Nb}_2\text{O}_5 + 2\text{Li}^+ + 2\text{e}^- \rightarrow \text{Nb}_2\text{O}_5(2\text{Li}^+)$

Overall battery reaction:  $\text{Nb}_2\text{O}_5 + 2(\text{Li} - \text{Al}) \rightarrow \text{Nb}_2\text{O}_5(2\text{Li}^+) + 2\text{Al}$

The cell voltage is approximately 2V.

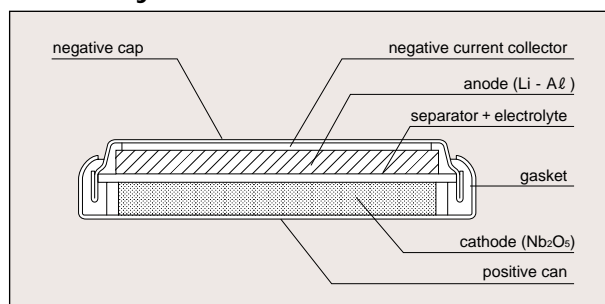


### When the batteries are used with a contact system

Use nickel-plated phosphor bronze or stainless steel for terminal materials to make contact with the batteries.

For stable contact conditions, several N of contact pressure are recommended for the contact.

### Battery Structure



### Applications

Memory backup power sources for pagers and portable cellular phones including PHS.

Power source for portable equipment.

Hybrid power source when combined with solar cells

Memory backup power source for electronic equipment.

## [ Features of Niobium Rechargeable Lithium Batteries ]

### Stable Operating Voltage of 1.2V

With a discharge voltage of 1.2V, Sanyo niobium rechargeable lithium batteries maintain stable voltage characteristics over a prolonged period.

### Charge/Discharge Characteristics

The NBL621 can withstand 3,000 cycles under discharge conditions of 0.2mAh (discharge depth of 5%)

### Wide Operating Temperature Range

The use of an organic electrolyte gives an extended operating temperature range: -20 to +60.

### Charging Possible with 1.8V

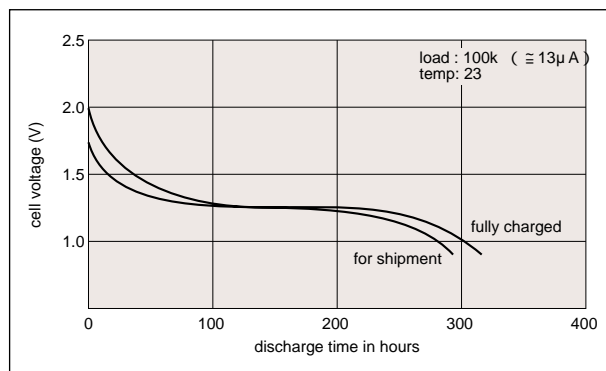
Even a charging voltage as low as 1.8V ensures high charge efficiency.

### Small Self-Discharge Rate Assures Durability

The self-discharge rate of approx. 2% per year at room temperature is much lower than that of Ni-Cd button cells. Even after five years of storage at room temperature, you can expect about 90% of the original capacity.

### Discharge

NBL621



### Greater Safety (UL approved)

Since Sanyo niobium rechargeable lithium batteries do not contain toxic materials, noxious liquids or gases, they pose no major pollution problems. They are UL recognized components (File No. MH12383).

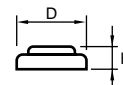
## [ Specifications of Niobium Rechargeable Lithium Batteries ]

Model	Nominal voltage (V)	Nominal capacity <sup>1</sup> (mAh)	Standard charge/discharge current (mA)	Max. discharge current (mA)		Charge/discharge cycle characteristics	Charging method	Dimensions (mm)		Weight (g)
				continuous <sup>2</sup>	pulse <sup>3</sup>		constant voltage charge	diameter (D)	height (H)	
NBL414	2	1.0	0.005	0.15	0.5	3,000 cycles (discharge depth of 5%) 300 cycles (discharge depth of 20%)	2.2 ± 0.4V 2.1 ± 0.3V (charge at high temperature or continuously)	4.8	1.4	0.07
NBL621	2	4.0	0.015	0.3	1			6.8	2.1	0.23

1 Nominal capacity is determined to an end voltage of 1.0V when the battery is allowed to discharge at a standard current level at 23 °C.

2 Current value is determined so that 50% of the nominal capacity is obtained with an end voltage of 1.0V at 23 °C.

3 Current value for obtaining 1.0V cell voltage when 15sec. pulse applied at 50% discharge depth at 23 °C.



## [ Connection Terminal Specifications ]

Sanyo meets various user requirements by developing an extended line of batteries with different terminal designs (tabs, connectors and other terminals) as well as various battery holders. Regarding standard specifications and key circuit design points, see the separately provided "Connection Terminal Specifications for Lithium Batteries and Key Circuit Design Points."

## [ International Transportation ]

Regulations for international transportation of lithium batteries may be largely classified into three categories.

### 1. Air transport

Based on DGR (Dangerous Goods Regulations) of ICAO (International Civil Aviation Organization), IATA (International Air Transport Association) has determined transport regulations. The regulation states that lithium batteries are considered not dangerous if they meet the following requirements:

Each bare cell with a solid cathode must contain 1.0g (Assembled battery using more than 2 cells must contain 2.0g) or less of lithium or lithium alloy. (Sanyo's lithium batteries are all solid cathodes.)

They may be transported in rigid packaging with short-circuit protection.

### 2. Marine Transport

IMO (International Marine Organization) has determined transport regulations based on IMDG (International Marine Dangerous Goods). The judgement standard of dangerous goods is based on DGR of ICAO. When the batteries are not regarded as dangerous goods, they should be transported in rigid packaging with short circuit protection, according to IATA standards.

### 3. DOT (Department of Transportation)

Regulations for packaging and transportation of lithium batteries in the U.S.A. are determined by Code 49 CFR173. 185 of Federal Register.

The judgement standard of dangerous goods corresponds to DGR of ICAO. When the batteries are not regarded as dangerous, any transportation method is acceptable if they are transported in rigid packaging with short circuit protection.

The following Sanyo lithium batteries contain less than 1.0g of lithium or lithium alloy (under 2.0g for assembled batteries) per single cell.

CR1220, CR2016, CR2025, CR2032, CR2430, CR2450, CR-1/3N, 2CR-1/3N, CR15270, CR15400, CR17335, CR17335E-R, CR17335HE-R, CR17450E-R, CR17450HE-R, CR2, CR123A, CR-P2, 2CR5, CR-V3, CR14250SE, CR12600SE, CR17335SE, CR17450SE, CR14250SE-R, CR17335SE-R, CR17450SE-R

Rechargeable Lithium Batteries

ML414, ML414R, ML421, ML614, ML621, ML1220, ML2016, ML2020, ML2430, NBL414, NBL621

Batteries containing more than 1.0g of lithium or lithium alloy (more than 2.0g for assembled batteries) per single cell are shown below.

CR23500SE, CR23500SE-R

## [ Disposal ]

The awareness of the need to protect the earth's environment has increased on a global basis. As a result, regulations covering the disposal and recycling of mercury cells and Ni-Cd rechargeable batteries have been implemented in the U.S.A., Europe and Japan. Since the relevant regulations vary by country and even by state, specific details should be obtained from your region's authorities.

# Sanyo lithium batteries supply power for a wide spectrum of applications.

## [ Categories and Applications of Lithium Batteries ]

Application		Primary Lithium Batteries					Rechargeable Lithium Batteries	
		high-power cylindrical type			high-capacity cylindrical type		coin type	
		spiral structure, crimp-sealing	spiral structure, laser-sealing		bobbin structure, laser-sealing		crimp-sealing	
		main power source	main power source	memory backup	main power source	memory backup	*main power source	memory backup
AV equipment	radio							
	TV/VCR							
	camera							
	camcorder							
	DSC							
communications equipment	telephone							
	cellular phone							
	PDA							
in-vehicle equipment	GPS/car stereo							
	ETC							
	emergency call system							
office equipment	copy machine							
	fax machine							
	computer							
light equipment	light							
	flash light							
	emergency lighting							
meters for utilities	water meter							
	gas meter							
	electricity meter							
	NCU							
others	remote control unit							
	clock							
	calculator electronic notebook							
	PC card/game machine							
	LED-related							
	medical/health-care equipment							
	measuring instrument							

\* denotes common use of solar cells.

The above table shows typical applications of lithium batteries.



SANYO Electric Co., Ltd. Soft Energy Company, as a part of the SANYO Electric Group, has received Environmental Management System ISO14001 certification.

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